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Forestry Research West

Forest Service
U.S. Department of Agriculture

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A report for land managers on recent developments in forestry research at the four western Experiment Stations of the Forest Service, U.S. Department of Agriculture

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In This Issue

Cover

Aspen trees are popular and important to our western forests. They are also very susceptible to diseases. Scientists at the Rocky Mountain Station have been studying several aspen diseases since the 1960's, and have helped identify several of them. Read more about it on page 12.

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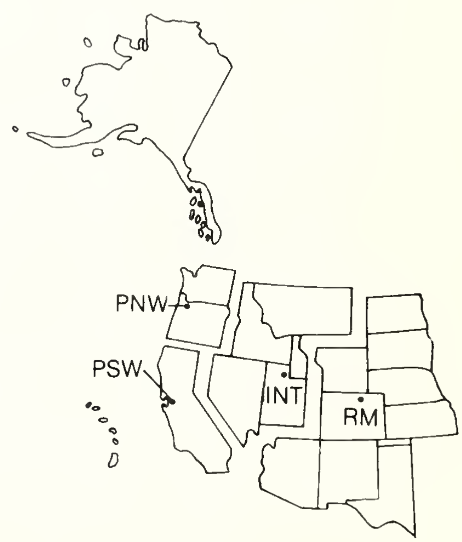


Prognosis: fortune-teller for forest stands

by Delpha Noble
Intermountain Station

Prognoses—forecasts of a future course or development based on knowledge—today are playing an increasingly important role in forest planning. How will the forest respond to silvicultural practices such as regeneration harvests, site preparation, planting, thinning, weeding or pest control? Where should investments be made? Have past practices turned out as expected?

Managers of public and private forest lands are obtaining answers to these and similar questions by using the Prognosis Model for Stand Development developed by researchers at the Intermountain Station's Forestry Sciences Laboratory, Moscow, Idaho. The model, a valuable tool for producing growth and yield tables, forecasts stand development strategies by simulating the growth and mortality of individual tree samples. One large forest products company has reported a 35-percent increase in timber harvest from their lands, based on the use of a collection of computer programs produced by Forest Service research. Prognosis is a key element in that collection.

One of the strengths of the model, says project leader Albert Stage, is that it is based on routine inventory data from forests where it is to be used. Therefore, it represents all conifer stands inventoried on forests in a specific geographic area. Equally important, it has been shaped and refined in response to suggestions and evaluations by many critical users.

Version 4 of the model, and the associated Users' Manual, were released at a workshop in Moscow, Idaho in July 1981, attended by over 90 foresters. Senior author William Wykoff, Nicholas Crookston, and Stage believe this version is a substantial improvement over its predecessors and one that should be stable for a time. Because they see the modeling process as a means to coordinate, assimilate, and organize quantitative information about ecosystems, the researchers believe continuing evolution of the model is necessary and inevitable.

Stage and the others developed the model explicitly for use in planning but they say it also may have research uses as well. According to Stage, models used for planning must be judged by different criteria than those representing scientific theory. Planning models require greater statistical validity but may be based on less complete theoretical knowledge of the system than are hypothetical models. Because plans are always a statement about the future, however, Stage says a good planning model should be a combination of theory and empirical data.

Multi-resource planning

Prognoses can be produced for any forest inventory that samples trees and their characteristics. The full capabilities of the model, however, are realized when the sampling unit is a stand, or even better, clusters of stands, and when the tree characteristics include radial growth and crown length. By examining all the stands in a cluster, managers may analyze interactions among adjacent stands and among the proposed treatments. For example, it is possible to interpret the effects of timber harvesting on wildlife and pest populations that range across or infest more than one stand. When the cluster includes an entire watershed, the model forecasts changes in stand cover so that effects on streamflow can be determined. For scheduling timber harvest, yield tables from classes of stands are compiled into composite yield tables. Results can be passed within the computer system to an economic analysis program designed by the University of Idaho to work directly with Prognosis.

The model may be used in conjunction with watershed and wildlife habitat models. The Stand Prognosis Model provides estimates of the vertical and horizontal distributions of conifer crowns, shrub cover, and production of wildlife browse. These capabilities have been used in the research program for the Gospel-Hump area of the Nezperce National Forest. In this application, prognoses are linked with a sediment transport model, an anadromous fishery model, and an elk and moose habitat model, all of which depend on the spatial patterns of treated areas.

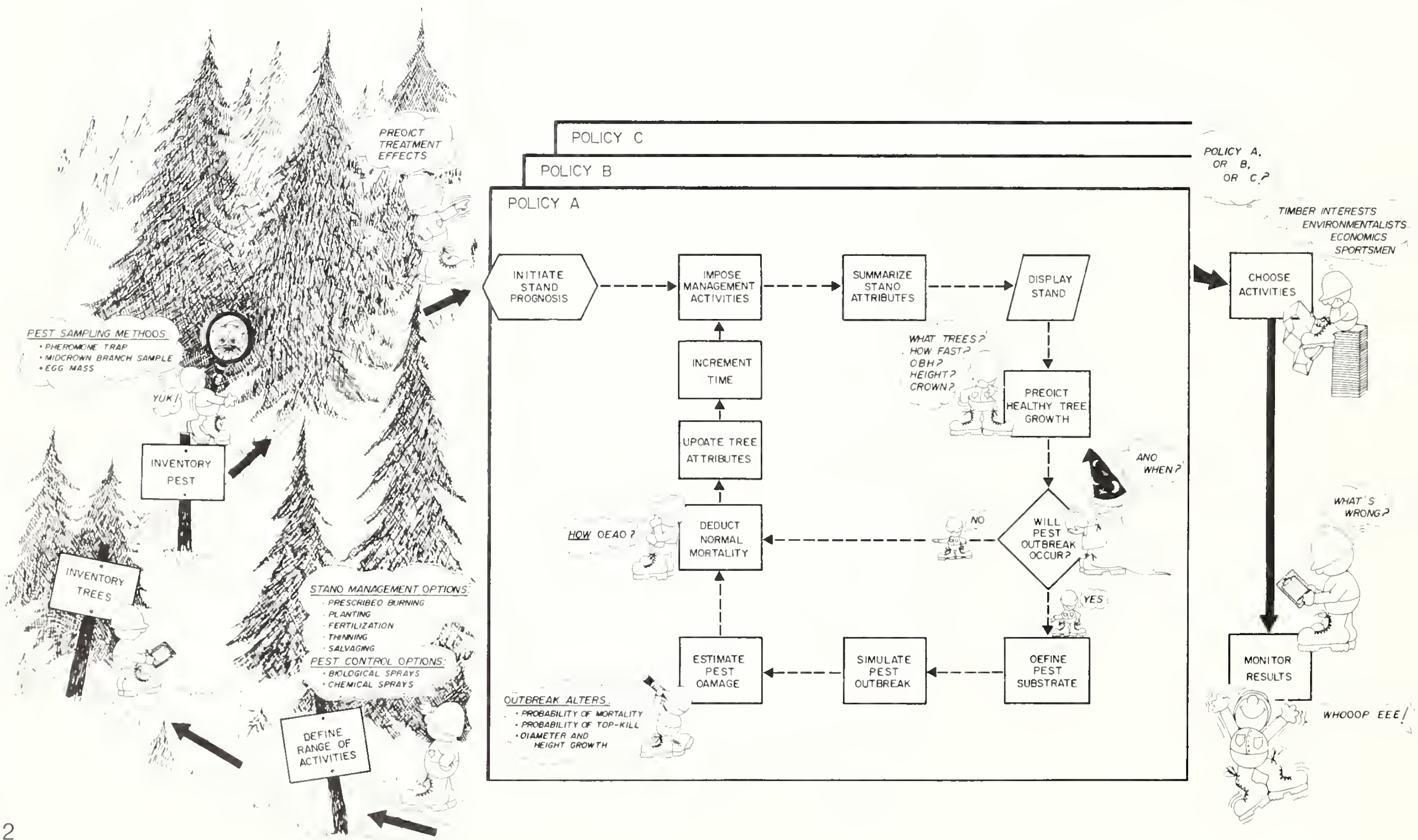
When the model is used with its several extensions to represent insect/pest impacts, it comes closest to the common use of the term prognosis: "A prediction of the course or development of a disease." Land managers concerned with pest infestations have long needed a method to estimate benefits from selected management practices. They have been stymied, however, by complex interactions between pest populations, the damage they cause, and the dynamics of stand development. Although Prognosis is not the first stand model used to analyze the impact of pests, it is one of the first to integrate a wide range of silvicultural practices with treatments of the pest population. As such, it can be a valuable tool for bringing pest management into the scope of silvicultural decisionmaking.

The pest-dynamics extensions also demonstrate the value of modeling for coordinating the efforts of large teams of independent investigators. The Douglas-fir tussock moth extension was the product of many people working in the Department of Agriculture's Accelerated Douglas-fir Tussock Moth Research and Development Program. Robert Monserud, mensurationist at the Laboratory, linked the tussock moth dynamics model with the Stand Prognosis model. Similarly, Crookston's work portraying the effects of mountain pine beetle on lodgepole pine stands was partly a product of research sponsored by the International Biome Program at the Intermountain Station, the University of Idaho, Washington State University, and University of California. Current work on the western spruce budworm extension is sponsored by the CANUSA (Canada-United States) Spruce Budworm Program.

How the model works

The Stand Prognosis Model begins with a stand inventory describing the site (habitat type, slope, aspect, and elevation) and attributes of representative sample trees. Current diameter and species must be recorded for the sample trees. Stage says it is highly desirable to record the length of live crowns and a sample of tree heights. If periodic growth is measured on two or more trees of a given species, the automatic calibration procedure will adjust the prediction equations to match the growth of the stand.

The model first compiles the inventory and produces tables describing current stand conditions. Then, the first of one or more projection cycles (up to 40 cycles are possible) is begun. The number of years in a projection cycle is variable. Each projection cycle begins with the simulation of a silvicultural option (one option is "no treatment"). Next, periodic diameter growth, periodic height growth, and periodic mortality rates are computed for each inventoried tree. After tree attributes are updated and tree volumes are calculated, tables describing the projected characteristics of the stand are prepared. Mechanical



site preparation, burning slash, planting and other practices that follow harvest cuttings can be specified. Estimates of the restocking that occur after these practices are based on Dennis Ferguson's extensive sampling and analysis of managed stands in the grand fir-cedar-hemlock ecosystem. The model displays the effects of tree vigor on growth only to the extent that vigor can be described by the length of live crown. Further improvements would depend on adding measures of tree vigor, such as the one developed by Silviculturist Charles Wellner for white pine. (Mr. Wellner, now retired, is a former Assistant Director of the Intermountain Station. He is an authority on the silviculture of Northern Rocky Mountain Forests.) As Researcher Russell Graham has shown, these tree vigor classes differ substantially in the likelihood of mortality.

What the model tells us about management

Models represent the expected. Comparisons between model-based forecasts and their actual counterparts, therefore, emphasize the surprises—the as yet unpredictable workings of the ecosystem. When the scientists compared their model to records of stand development extending as long as 60 years, they determined that the estimates of individual tree growth were accurate. Most of the forecasting errors were the result of irregular mortality. Stage says that fact is not surprising, but "What is significant is the amount and variation of the mortality losses."

In Inland Empire forests, almost one third of the total productivity is lost to mortality. Although managed stands lose somewhat less, the magnitude of the losses emphasizes the need to plan for their utilization. Mensurationist Dave Hamilton has developed monitoring and analysis procedures, tailored to the inherent variability of mortality, that should be useful for locating and estimating losses. The researchers suggest, however, that rather than lamenting the problem, managers should include in their plans flexibility to adapt to the unpredictable but inevitable losses. This unpredictability should also influence the design of road and harvesting systems and of systems for marketing the dying trees. "Finding ways to capture these losses probably can do more to improve the total productivity of our forests than any other silvicultural treatment," says Wellner.

Accessing the model

Models as comprehensive as Prognosis require a substantial computer to run them efficiently. Large forestry organizations with their own computer systems have obtained copies of the model and have procedures by which field foresters can enter stand inventories and compare management alternatives. For potential users without computers, inventory data can be sent to the University of Idaho or University of Montana for processing. Extension Foresters and the Forest Service branch of State and Private Forestry periodically conduct workshops to show how these services can be obtained.

At present the Inland Empire version, supported by the Intermountain Station, is the most widely used. Geographic variants, tailored to local biological conditions, are being developed by various groups of users for central Idaho, southwest and eastern Oregon, central Washington, eastern Montana, and western Wyoming.

If you're interested in reading indepth reports on the role of modeling in forest management, here are a few suggestions:

Stage, Albert R., Richard K. Babcock, and William R. Wykoff. 1980. *Stand-oriented inventory and growth projection methods improve harvest scheduling on Bitterroot National Forest.* "Journal of Forestry," 78(5): 265-278. (Reprint INT-680).

Wykoff, W. R., N. L. Crookston, and Albert R. Stage. In press. *User's guide to the stand prognosis model.* USDA Forest Service General Technical Report. Intermountain Forest and Range Experiment Station, Ogden, Utah.

Stage, Albert R., and Dennis E. Ferguson. In press. *Regeneration modeling as a component of forest succession simulation. In* Proceedings, Symposium on Forest Succession and Stand Development Research in the Northwest (March 26, 1981, Corvallis, Oregon.)

Hamilton, David A. 1981. *Large-scale color aerial photography as a tool in sampling for mortality rates.* USDA Forest Service Research Paper INT-269, 8 p. Intermountain Forest and Range Experiment Station, Ogden, Utah.

Stage, Albert R. 1978. *Stand prognosis model—the central link in a decision-support system for forest managers.* Proceedings, Society of American Foresters 1978: 256-257.

Brookes, Martha H., R. W. Stark, and Robert W. Campbell, eds. *Douglas-fir tussock moth: a synthesis.* USDA Forest Service Technical Bulletin 1585. Washington, D.C.

Crookston, Nicholas L. 1978. *Predicting the outcome of management activities in mountain pine beetle susceptible lodgepole pine stands.* Proceedings, Society of American Foresters 1978: 276-280.

Graham, Russell T. *White pine vigor—a new look.* USDA Forest Service Research Paper. INT-254, 15 p. Intermountain Forest and Range Experiment Station, Ogden, Utah.

Further information on Prognosis can be obtained by writing:

USDA Forest Service
Intermountain Forest and Range
Experiment Station
Forestry Sciences Laboratory
1221 S. Main St.
Moscow, Idaho 84843

Timber harvesting and water quality in the Bull Run Municipal Watershed

by Samuel T. Frear
Pacific Northwest Station

The Bull Run Municipal Watershed is a forested, often foggy, area of 95,000 acres in Oregon's Mount Hood National Forest that provides water to the City of Portland 30 miles to the west. Controversy has swirled about this area for many years. There has been public questioning about how the watershed, the major source of water for more than 800,000 people, should be managed.

Scientists from the Pacific Northwest Station became involved back in 1955 when the Forest Service agreed with the City of Portland that more technical information about the watershed was needed.

The basic problem has been over water quality: can roads be built and timber removed without damaging the clean, pure water required by the citizens of Portland? The Pacific Northwest Station's assignment: determine the effects of timber harvesting on the quantity and quality of water in the Fox Creek stream system of Bull Run.

Fox Creek was selected for the study because it presented an opportunity to have three untouched and similar subdrainages for conducting experiments. One subdrainage was used as a control, while different management practices were applied in the other two. The Fox Creek sites are relatively gentle terrain. About 30 percent of the total Bull Run watershed is similar to them.

The formal part of the research agreed to in 1955 is now concluded. The research shows that timber harvest can be done without causing significant impacts on the quantity and quality of water in those parts of the Bull Run which are like the study area. This research, combined with studies from other sites in the Oregon Cascades, provides managers with data upon which plans can proceed that will permit the Forest Service to conduct timber management in the drainage, while the City of Portland provides pure water to its citizens.

In most respects Bull Run resembles drainages all along the western slopes of the Cascade Range in Oregon and Washington. It is covered with old-growth Douglas-fir and hemlock and has many small streams descending to the valley below. Sunlight rarely reaches the forest floor; in the cool, dark forest there is much moss, lichen, and fern.

The lower portions of Bull Run lie at 800 feet elevation; the upper parts at about 4,200 feet. The drainage slopes to the west where clouds that sweep in from the Pacific Ocean can be scooped up. Many clouds come into Bull Run: rainfall at the lower portions, measured since 1957, averages 106 inches annually, with 83 percent falling from October to April. Rainfall in the upper reaches of Bull Run averages 170 inches annually.

A Bull Run Watershed Task Group, appointed jointly by the Forest Service and the City of Portland, in September, 1980 made a report on water quality management in the area. This group reported of Forest Service research at the Fox Creek site: "In general, the results of this work indicated that timber harvest had little effect on the quality of the water resource", suggesting, "that logging can be carried out on the watershed without adversely affecting the water quality."

Richard Fredriksen, research soil scientist with the Station's Forestry Sciences Laboratory in Corvallis, Oregon, agrees. He said that logging can cause little adverse effect on water quality if it has been carefully planned and executed.

Fredriksen reached this conclusion from research conducted at several sites in western Oregon, including the Fox Creek drainage. The Fox Creek study includes three watersheds. Fox Creek 1 (FC 1) had road construction and cable logging. Fox Creek 2 (FC 2) was the control, with a road crossing it. Fox Creek 3 (FC 3) had a road and both cable and tractor logging was used. The slash was burned on FC 1 and left to rot on FC 3.

An all-weather road was completed across FC 1 and 2 to the south boundary of FC 3 in August, 1965. FC 1 and 3 also had short temporary spur roads. Timber was clearcut in FC 1 in four units of 7 to 10 acres each, and high lead logging was completed in July, 1969. Logging residue was burned in the fall of 1970. Logging took place in FC 3 over a three-year period in two units of 19 and 24 acres, starting in 1969 and ending in 1972. No residues were burned in this watershed.

Stream gages were placed at the base of the three watersheds by the City of Portland Water Bureau in 1958 when the area was undisturbed. Automatic sampling devices filled five-gallon jugs with water to be tested for turbidity, nutrients, and other characteristics. Rain gages were set up for determining quantity and quality of precipitation. Both air and soil temperatures were monitored with recording thermometers (thermographs).

Month after month, year after year, scientists and technicians tended these instruments: lugging in batteries to run the samplers, and lugging out bottles of water for chemical analysis in Corvallis. The recording instruments were read and recorded and revitalized. The result was reams of data for analysis by scientists.

The four important water quality parameters that can be studied for a forest drainage are turbidity, nutrient enrichment, temperature, and microbial content. The study of Fox Creek includes all except microbial content.

Turbidity

Turbidity, as measured by passing a beam of light through a water sample, usually results from suspended soil particles caused by erosion, some natural and some that originate from soils disturbed by road construction and logging. In western Oregon, landslides are the principal process by which soil enters streams. The years of research have shown that turbidity usually can be avoided in Bull Run. Fredriksen says it is geologically a very stable piece of ground compared to other west-side drainage basins.

Just how stable is shown by comparing Bull Run to other watersheds, for example, in the Mapleton District of the Siuslaw National Forest, the H.J. Andrews Experimental Forest and the Alder Creek area of the Willamette National Forest, Stequaleho Creek on the Olympic Peninsula in Washington, and the Coast Mountains in British Columbia. Compared to these, Bull Run has by far the lowest rate of landslide movement.

The stability of Bull Run is further shown by research indicating that slumping earthflow terrain, the most susceptible for flowing into streams, makes up only 3.2 percent of the area (compared to 25.6 percent in the H.J. Andrews Forest just 50 miles away). The parent material in Bull Run is 97 percent basalt and andesite material which is able to support its own weight (and thus not likely to slide).

A rain gage stands in the Fox Creek area of the Bull Run Watershed in the Mt. Hood National Forest. The gage requires constant attention to record its intake and prepare it for the next rainfall.

This is one of the clearcut units in Fox Creek 1. It was cable yarded and burned in 1971.

This is the same Fox Creek unit in 1975.

Nutrient Enrichment

Nutrients entering streams following timber harvesting are increased because trees no longer take them from the soil and they are flushed by rain into streams. Also affecting increased supply is the conversion of tree tissue to disposable slash and its decomposition releases nutrients. Fredriksen said that analysis before logging occurred in Fox Creek showed that concentrations of nutrients from the Fox Creek watershed were much lower than concentrations from similar watersheds. "We don't know why," he said. "But our best guess is the low temperature. The storage of elements in soils is very low, and the release of nutrients from the bedrock to streams is slow due to low temperature. It is not typical at all of the older volcanic soils such as those in the Willamette and Umpqua National Forests to the south."

After harvesting, nitrogen is mineralized in quantities exceeding vegetation requirements and the ability of soils to store them. Thus, an increase in nitrate concentration in streams is usually expected after logging, and this happened at Fox Creek. Although nitrogen in the streams increased considerably, Fredriksen said it did not have an important affect on the quality and usefulness of water in the reservoirs. In time, vegetation growth in clearcut units will use the nitrogen and its production will become balanced again. An increase in phosphorous concentration could lead to increased growth of algae in the reservoir, but this has not happened.

Water temperature

Increased temperature of stream water frequently results from timber harvesting because the streams are opened to sunlight. The effect is moderated by dilution from cooler ground water entering streams and by shade from regrowth of vegetation beside streams. Larger streams and reservoirs can reduce the stream temperature by mixing warmer water with cooler water or by stratifying water of different temperatures in layers. Timber harvesting can be accomplished to minimize warming effects, such as by leaving shade producing vegetation.

Streamflow

In addition to studying the turbidity, nutrient enrichment, and water temperature at Fox Creek before and after logging, the researchers studied the quantity of water flowing from the drainage. Based on watershed studies in other parts of the Pacific Northwest, the researchers expected that streamflow would increase following logging in watersheds FC 1 and 3 because logging removes vegetation that uses soil water. But Dennis Harr, a research hydrologist in Corvallis, compared stream flow records among watersheds and found that water yields in the Fox Creek watersheds were not appreciably changed after logging.

Analysis of streamflow for the Fox Creek watersheds indicated a small decrease in water yields instead of the expected increase of 4 to 6 inches (100 to 150 mm). This is contrary to what had been found by studies in other partially logged watersheds. In addition, the number of low-flow days in the summer (days with flow below an arbitrary base level) increased during many post-logging years at Fox Creek. This suggests that summer flows have decreased following logging, another unexpected result from Fox Creek, but the probable cause has been found: fog drip.

Fog drip

Changes in fog drip after logging appear to explain the anomalous results of the Fox Creek streamflow study. Fog is common at the elevation of these watersheds, and field crews have frequently experienced rainfall in the forest during periods when no rain was collected in a gage in a nearby clearing.

During a 40-week period, Harr found net precipitation under an old-growth Douglas-fir forest in Bull Run totaled 16.5 inches (387 mm) more than in adjacent clearcut areas. Making adjustments, the scientist calculated that in a full year fog drip could have added 35 inches (882 mm) of water to total precipitation when a rain gage in a nearby open area measured 85 inches (2160 mm). Thus he concluded that logging removed a significant source of precipitation: fog interception and drip. This offsets the expected increases in water yield that would result from timber harvest.

The other streamflow anomaly at Fox Creek—the increased number of "low flow" days—is probably also explained by fog drip. The relative amount of fog drip was greatest during the summer so that when forest stands were cut as much as a third of precipitation could be eliminated.

Accurate assessment of logging impacts on fog drip and water yield will depend not only on the long-term management plan for the Bull Run Municipal Watershed but also on the nature of fog drip. Harr emphasized that additional information on the areal distribution of fog drip and the size at which young trees catch significant amounts of fog is needed before the long-term impact of logging on water supplies can be determined.

If you would like more information about this research, write to the Pacific Northwest Station and request *Streamflow after Patch Logging in Small Drainages Within the Bull Run Municipal Watershed, Oregon*, Research Paper PNW-268, by R. Dennis Harr.

Classifying plant communities—a new way

by Marcia Wood
Pacific Southwest Station

This river ecosystem includes elements of both the Graminoid and Aquatic Subformations.

"Any time people from different professions try to work together on any sort of plan that involves wildland vegetation, there are bound to be problems about how to describe and classify the vegetation. A botanist, trained in classifying communities of wildland plants according to one method, may need to talk about this vegetation with a forester. If the forester is used to working with an entirely different classification system, there's going to be some confusion and frustration!"

These are the opinions of Research Forester Tim Paysen of the Pacific Southwest Station in Riverside, California. "In this State, you can choose from at least 20 different systems for classifying communities of wildland plants," he says. "This diversity makes it hard for people to work together well."

In an attempt to resolve this problem, Paysen and colleagues from several other wildland management agencies developed yet another classification system. Theirs takes a different approach from systems that were designed with just one specialized use—such as timber management or range management—in mind. "Our intent is to meet the combined needs of the ecologist, the botanist, the forester, the range manager, the wildlife biologist, and other people in natural resources management. Our system should solve the communication problem, with a minimum of inconvenience to any of these disciplines or to any wildland management agency."

The new approach

Known simply as "A Vegetation Classification System for California," the new classification scheme applies to any and all wildland vegetation in the State. Paysen and four collaborators have already shown how the System can be used to classify all southern California vegetation (see *A Vegetation Classification System Applied to Southern California*, General Technical Report PSW-45).

Here's how the Classification System works:

The System has five "levels". The "Formation" is the broadest, most general category. Following the "Formation," the categories become more and more specific. These other categories are the "Subformation," "Series," "Association," and "Phase."

Some examples: The Closed Forest Formation describes stands where overstory crowns of pines, firs, or other trees make up more than 60 percent of the total crown cover. The Woodland Formation is more open. It can include conifers, hardwoods, or—in the case of southern California vegetation—large succulents such as palms or Joshua trees. Trees in this Woodland Formation are more widely spaced than those in the Closed Forest Formation. The crowns of the Woodland Formation trees make up between 25 and 59 percent of the total crown cover.

Other Formations

Brush species and cacti are among the dominant species in the Shrub Formation. Here, shrubs make up more than 25 percent of the crown cover, and grow to be at least 1-1/2 feet (45 cm)tall. Plant communities dominated by shrubs that never reach this height would fit into another category—the Dwarf Shrub Formation.

What about grasslands? These are part of the Herbaceous Formation. In it, the dominant plants are grasses and herbs. Shrubs or trees provide less than 25 percent of the crown cover.

"Subformations" defined

"Each Formation is an aggregation of plant communities that are similar in structure or appearance," Paysen says. These component communities are called Subformations. All of the dominant overstory plant species in a given Subformation have similarly shaped stems and leaves. In the Conifer Forest Subformation, for example, the dominant overstory species have either the needle-like leaves of pines and firs, the scale-like leaves of redwood or cypress, or the awl-shaped leaves of giant sequoia.

The Conifer Forest Subformation is part of the Closed Forest Formation. In line with the definition of the Closed Forest Formation, the canopy of the Conifer Forest Subformation makes up at least 60 percent of the total crown cover.

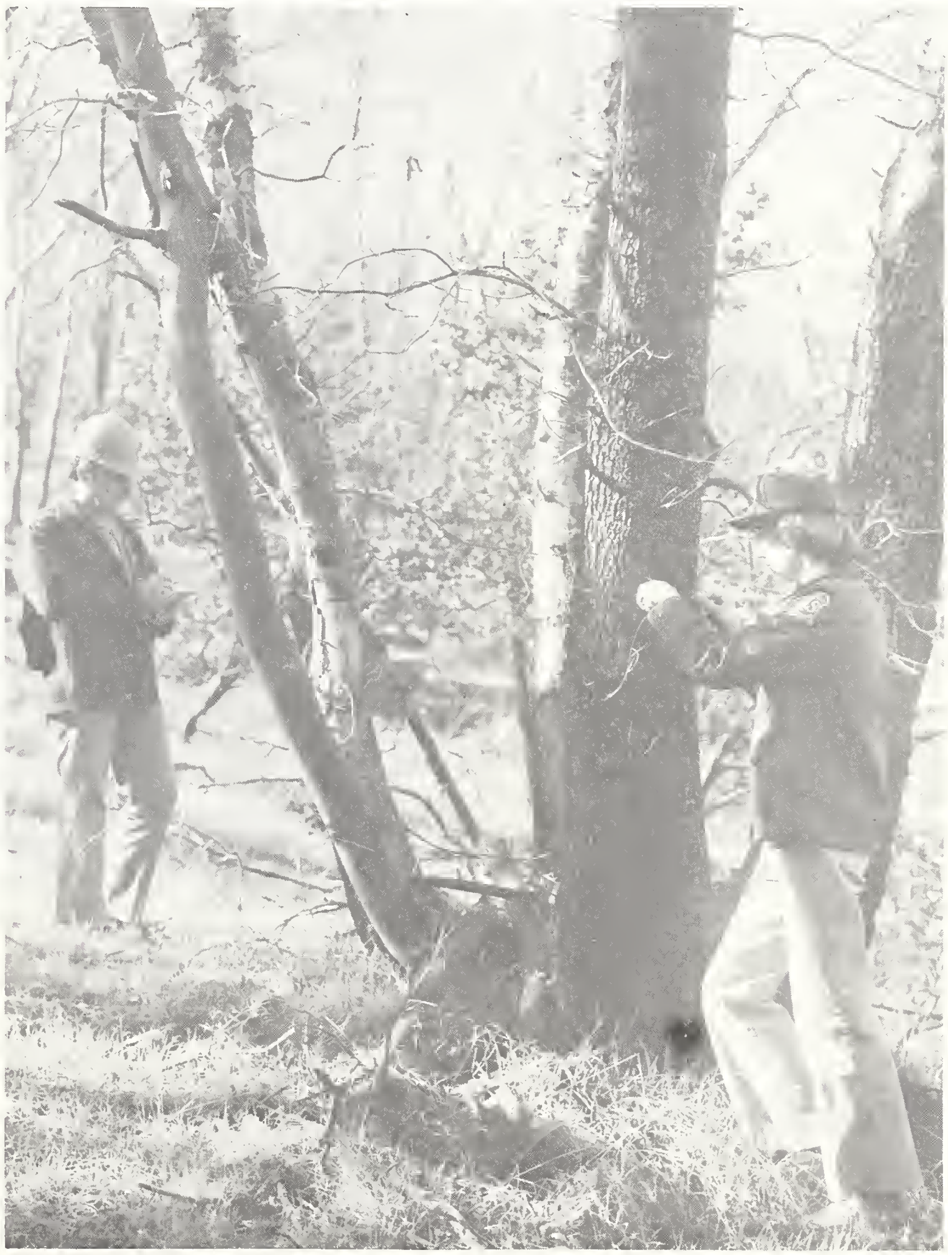
But what if the conifers aren't as dense, and take up less than 60 percent of the crown cover? In southern California, this is often true of digger pine, pinyon pine, and juniper. If these trees make up between 25 to 59 percent of the total crown cover, the community meets the definition of a Conifer Woodland Subformation. This Subformation is, in turn, part of the Woodland Formation.

This aspect of the System may take a little getting used to, because most people are accustomed to thinking of "woodlands" as forests of hardwoods—oak, madrone, and similar species. The trick is to remember that "Woodland" refers only to the density of the canopy. It indicates that the community is more open than the Closed Forest Formation. A "Woodland" isn't limited just to hardwoods—it can be made up of conifers, or even succulents.

Hardwoods, or broadleaved trees, can belong to either the Closed Forest or the Woodland Formation, again depending on the density of the crown cover. Open stands of California buckeye, cottonwood, mesquite, blue oak, sycamore, and willow, for example, would probably be part of the Broadleaf Woodland Subformation of the Woodland Formation—if the crowns of these trees make up between 25 and 59 percent of the crown cover. Dense stands of aspen, alder, California bay, bigleaf maple, tanoak, or madrone would probably be classified as part of the Broadleaf Forest Subformation of the Closed Forest Formation, if crowns of these trees provided more than 60 percent crown cover.

The "Associations"

Each of the Subformations is further described by the Series and Associations that it contains. The Series is a collection of Associations. Each Association within a Series has the same dominant overstory species.



Tim Paysen and Serena Hunter have classified this community as belonging to the Kellogg Oak Series, and are now writing a more detailed description of the stand.

An example: the Coulter Pine Series is one of some 17 different series that make up the Conifer Forest Subformation in southern California. Coulter pine is the dominant species in the Series.

What Associations could make up the Coulter Pine Series? One example would be a plant community in which Coulter pine was the dominant overstory species, interior live oak was the dominant in the midstory, and ceanothus was dominant in the shrub layer. This plant community would be called a Coulter Pine/Interior Live Oak/ Ceanothus Association.

What if the vegetation were somewhat different—Coulter pine still the dominant, but no live oak midstory, and manzanita—not ceanothus—as the dominant shrub? Then the vegetation would be labelled a Coulter Pine/ Manzanita Association. Both this Association and the one with live oak and ceanothus would belong in the Coulter Pine Series, because Coulter pine is dominant in both cases.

"Phases" explained

Finally, the Phase. "The purpose of the Phase category is to give users a chance to plug in additional descriptions," Paysen says. He suggests categories of Phases in the Southern California Vegetation Classification report. For example, a forester may need some further description of the Coulter Pine/Interior Live Oak/Ceanothus Association, such as the diameter breast height of the pines. Following the Southern California guidelines, the designation Coulter Pine/Interior Live Oak/Ceanothus Association, Phase 2, could be used to describe stands where the pines average 1 to 5 inches in diameter. Or, let's say that a fuels management specialist—someone concerned about the amount of flammable natural fuels that accumulate in the forest—wants to know more about the ceanothus, a plant that can burn easily during the dry months. A Phase could be used to indicate the density of the ceanothus.

"Phases can describe almost any major characteristic of the plant community," according to Paysen. "Phases are optional—they can be added, if needed, or left out, if not. They can be used at any level of the hierarchy, not just at the Association level."

Adaptability

The System is specific enough—especially at the Series and Association levels of the hierarchy—to accurately describe the vegetation on small, local sites. But, it is also general enough—in the Formation and Subformation, for example—to use on a much larger scale.

The System is compatible with one that scientists at the Rocky Mountain Station in Fort Collins, Colorado, are developing for nationwide use by the Forest Service. It can also be used in conjunction with the international system for classifying vegetation that was developed for the United Nations Scientific, Educational, and Cultural Organization.

In addition to on-the-ground evaluations, aerial photography is used to locate and define Associations, Series, and Phases. Here, Mary Hotchkiss uses aerial photography to check the distribution of a Series.

This community was classified as a Desert Mountain Mahogany/Sagebrush Association of the Chaparral Subformation, Shrub Formation.

Other systems

The System's developers made an extensive review of other major classification systems before coming out with their product. Among the systems they studied included those developed by Browne and Lowe; Cheatham and Haller; Driscoll, Russell, and Meier; Kuchler; Mueller-Dombois and Ellenberg; Munz; Thorne; and Wieslander. The System closely follows the suggestions of Soil Scientist Andy Leven and Botanist Ed Horton, both of the Forest Service's Pacific Southwest Region (National Forests of California).

Foresters, ecologists, biologists, and range scientists all had a hand in developing and critiquing the System. Representatives of Southern California Edison Company, the California State Department of Fish and Game, the Pacific Southwest Region of the Forest Service, the Fish and Wildlife Service, and the Bureau of Land Management were among the agencies consulted as the System progressed.

Current users

Among the National Forests in California using the Classification System is the San Bernardino. Forest Botanist Jeanine Derby, who helped develop the System, says some 800,000 acres—the entire Forest and some private lands within the Forest—have been classified to the Series level. "This information has been used on several projects," Derby reports. "On some grazing lands within the Forest, the Series designation indicates how often the vegetation—which in this case is shrubs—should be burned, to keep the preferred species of plants dominant, and to prevent the stands from becoming decadent."

The silver cholla cactus is a dominant understory species in the Desert Apricot/ Mojave Yucca/Silver Cholla Association.

The System presents a framework that can be used anywhere, as shown by the fact that the State Division of Forestry and Wildlife in Hawaii is using it. "The System is designed so that it can be applied to any vegetation, whether that vegetation has ever been seen by the original developers of the System or not," says Research Forester Serena Hunter of the Pacific Southwest Station. Hunter has worked with Paysen in explaining the System to prospective users. Her perspective: "An Interior Live Oak/Manzanita/ Needlegrass Association should mean the same thing to every agency or other group that is using the System. The results of classifying a plant community to one or all of the hierarchical levels of the System should be similar —within an acceptable degree of tolerance—no matter who is doing the classifying."

Forestry Research West readers who would like more information are welcome to call Tim Paysen at the Forest Fire Laboratory (714) 351-6552 (FTS: 796-6552) or to write him at the Laboratory, 4955 Canyon Crest Drive, Riverside, California 92517.

Tree diseases—bane of aspen

by Rick Fletcher
Rocky Mountain Station

Quaking aspen is one of the most popular and widespread tree species of western mountains. Trees can live to be 200 years old and obtain heights of 100 feet or more. Aspen are esthetically important around campgrounds and other developed areas, are a favored habitat for a variety of wildlife, and have recently been recognized as valuable by the timber and pulpwood industries.

Despite its amenities, aspen has one major drawback—its high susceptibility to diseases. The bark is a thin, soft, living part of the tree, and a poor protector against wounds, insects, and diseases. Of all aspen diseases, cankers are by far the most serious cause of tree death. A survey of 5 national forests in Colorado showed 11 percent of all aspen trees had one or more types of cankers. Similar situations exist in aspen stands throughout the West, including Alaska, Canada, and parts of Mexico.

A canker is a lesion, usually on the trunk, caused by a fungus entering through a tear or puncture in the bark. Scientists believe that the invading fungus produces a toxin which results in cell death, bark collapse, and localized death of the living tissue. With time, the canker spreads. If cankers girdle the trunk, nutrient flow is cut off, resulting in tree mortality.

The diseases

Scientists with the Rocky Mountain Station's Forest Diseases in the Rocky Mountains and Southwest unit at Fort Collins, Colorado, have been studying aspen diseases since the 1960's. They have helped identify several of them. The following is a look at some of the most common canker diseases:

Sooty-bark canker, caused by the fungus *Cenangium singulare*, is the most lethal canker of western aspen. Frank Hawksworth, Research Plant Pathologist and Project Leader for the Fort Collins unit says, "Upon penetrating the inner bark and cambium, it spreads rapidly—up to 40 inches per year—and can result in cankers 12 feet long in just 4 years time." Trees of all sizes are killed, usually in 3 to 10 years. As the tree succumbs, the dead bark crumbles to a sooty-bark residue—hence the name sooty-bark canker. This disease is found mainly on larger trees older than 60 years of age in the middle elevation range of aspen.

Black canker is another common enemy of aspen. It is plentiful in localized areas where up to 50 to 65 percent of the trees can be infected.

During a 12-year period, almost 70 percent of the aspen in this once heavily forested campground succumbed to diseases.

A Cenangium canker girdled and killed this aspen in six years. The wound was caused during a logging operation.

The fungus, called *Ceratocystis fimbriata*, invades the inner bark and cambium during the tree's dormant season, and kills a portion of the tissue. This process is repeated year after year, forming a black-target-shaped canker.

Research Plant Pathologist Thomas Hinds, also with the disease project, and one who has spent many years studying aspen diseases, says, "Because tree circumference growth usually outpaces black canker growth, single cankers seldom kill a large tree unless two or more combine to girdle the trunk."

Black canker, however, does cause trunk deformity and brown stain and wet wood extending into the heartwood.

Crytosphaeria is the newcomer to the list of aspen cankers. Although the fungus *Cryptosphaeria populina* has been known to exist for some time, it was just recently related to canker formation. Since its discovery, it has been found from Mexico northward throughout the Rockies to Canada and into Alaska.

The cankers, usually associated with trunk wounds, are long and narrow. Small trees often die within two years, even when not girdled. Large trees may survive longer. The infected bark around the canker is light brown to orange. As the bark dies, it becomes black and sooty-like, similar to sootybark. However, it is easy to distinguish as the dead bark contains small, light-colored areas from 0.5 to 2.0 mm in size.

The most common fungus found on aspen, *Cytospora chrysosperma*, causes Cytospora cankers. This fungus readily enters bark that has been injured or weakened, even through dead and dying twigs.

Trunk cankers form a dark brown to black circular pattern. Dead bark remains attached to the tree for 2 or 3 years. It then turns light brown and falls off in large pieces.

Although the fungus may be active in the bark, cankers are usually slow to form. Fruiting bodies of the fungus are often evidenced, however, by long, coiled, orange to dark red masses called spore tendrils, spore horns, or cirri on the dead outer bark. Large healthy trees often outgrow Cytospora cankers.

Hypoxylon canker is less important to western aspen than the ones covered so far. Caused by the fungus *Hypoxylon mammatum*, it is, however, the most damaging in the Lake States Region, and occurs in aspen stands throughout the eastern United States.

Diseased bark is mottled black and yellowish-white. About a year after infection, the fungus produces pillar-like structures that cause blistered areas in the center of the canker.

Infected trees often die before they are completely girdled. Low density, mixed, and thinned stands tend to have more infection, as do trees on the edges of stands, rather than within.

Although not a canker disease, "droopy aspen", is an unusual disorder that has appeared in recent years damaging ornamental trees in mountain communities, and to a lesser extent, in natural forest stands. The twigs become elongated and rubbery, and the affected trees droop like a weeping willow. The malady causes premature death. Studies are being conducted in cooperation with the Department of Botany and Plant Pathology at Colorado State University to determine the cause of this condition and a basis for developing control measures.

Other aspen cankers are known, but are not as widespread, and are considered less of a problem than those listed here.

Control methods

Although no chemical control measures are known for aspen cankers, silvicultural controls have met with some success.

These Ceratocystis cankers are about 12 years old and probably began from camper caused wounds. Notice the carvings in the bark.

Removal of cankered trees will help eliminate the disease source and provide additional space for healthy trees. Aspen stands should not be opened up too quickly, however, because they are sensitive to sunscald and the stand could rapidly deteriorate.

Since canker diseases usually increase with stand age, managing aspen in small uneven-aged groups on a rotation of 80 to 100 years is suggested.

If a stand is heavily infected, clearcutting or prescribed burning may be the best alternative. "In fact," says Hinds, "we are suggesting that clearcutting may be the best management strategy for aspen, whether the stand is diseased or not. Since the bark is so susceptible to wounds, it is difficult and costly to thin diseased trees without damage to the healthy ones. And, once the bark on healthy trees is wounded, it opens the door to fungus infection and you are back to a diseased stand again within a few years. Whereas, clearcutting will not only allow aspen to resprout and produce a vigorous new stand, but will reduce the disease impact and avoid a change in the stand to mixed or less desirable tree species."

If especially high-value trees (such as in campgrounds or in urban settings) develop cankers, it is possible in the early stages of infection to cut out the fungus. All infected bark, wood, and healthy tissue within two inches of the canker, must be cut away using sterile tools. The exposed wood should then be covered with a tree wound dressing.

Through continued research and proper management, we can rest assured that aspen and all its benefits will be around for a long time to come.

For further reading, the following publications are available from the Rocky Mountain Station (see the inside front cover for the address).

Hinds, Thomas E. and Eugene M. Wengert. 1977. *Growth and Decay Losses in Colorado Aspen.* USDA Forest Service Research Paper RM-193.

Juzwik, J., W. T. Nishijima and Thomas E. Hinds. 1978. *Survey of Aspen Cankers in Colorado.* A reprint from *Plant Disease Reporter,* Vol. 62, No. 10.

Hinds, Thomas E. and Thomas H. Laurent. 1978. *Common Aspen Diseases Found in Alaska.* A reprint from Plant Disease Reporter, Vol. 62, No. 11.

Hinds, Thomas E. 1976. *Aspen Mortality in Rocky Mountain Campgrounds.* USDA Forest Service Research Paper RM-164.

Hinds, Thomas E. 1981. *Cryptosphaeria Canker and Libertella Decay of Aspen.* A reprint from *Phytopathology,* Vol. 71, No. 11.

Droopy aspen is especially prevalent in aspen planted for landscaping purposes. It has also shown up in natural stands, however.

New publications

To Order Publications

Single copies of publications referred to in this magazine are available without charge from the issuing station unless another source is indicated. When requesting a publication, give author, title and number.

Analyzing residues in Pacific Northwest forests

There is increasing interest in the Pacific Northwest in the millions of tons of residues remaining in the forest after logging: Can it be used to generate energy? Is it a valuable source of material needed by the pulp and particle board industry?

Two reports by James Howard of the Pacific Northwest Station provide improved means of analyzing forest residues.

The first presents the characteristics of residue material in Oregon, Washington, and Idaho that affects its potential use for energy and other products. Data collected from measurements on 518 plots in the three states provides volumes by diameter and length, number of pieces per acre, percent of residue that is sound, average percentage of bark, and accessibility by slope and distance to road.

The second report describes a method to estimate the amount of logging residue in an area, using ratios which relate the quantity of residue to the volume of timber or number of acres harvested.

Copies of *Logging Residue in the Pacific Northwest: Characteristics Affecting Utilization,* Research Paper PNW 289, and *Ratios for Estimating Logging Residue in the Pacific Northwest*, Research Paper 288, both by James O. Howard, are available from the Pacific Northwest Station.

Managing and rehabilitating the backcountry

As recreational use of backcountry areas continues to increase dramatically, land managers are concerned with maintaining the quality of this resource. This is particularly true for areas in the National Wilderness Preservation System and the backcountry of National Parks where a major goal is to preserve "natural conditions."

To deal effectively with the problem of human disturbance in these areas, managers must understand ecological processes and the relationship between visitor use and impact. They must also be aware of practical methods of managing users and rehabilitating excessively damaged sites.

A report issued by the Intermountain Station can help managers meet these needs. David N. Cole and Edward Schreiner have compiled an interpretive bibliography on backcountry impacts, management, and rehabilitation. The report, containing 300 references, is primarily concerned with recreational impacts on the soils and vegetation of backcountry areas and how to rehabilitate sites that have received excessive impact.

Write to the Intermountain Station for a copy of *Impacts of Backcountry Recreation:. Site Management and Rehabilitation*, INT-GTR-121, FR 29.

Behavior of phenoxy herbicides and TCDD summarized

Scientists are not able to resolve the emotional and philosophic elements of the public controversy about herbicide use in forests, however, they continue to compile technical data to assist in the continuing debate.

Logan Norris of the Pacific Northwest Station has written an extensive review of the technical literature on the movement, persistence, and fate of phenoxy herbicides and TCDD in the forest. Both phenoxy herbicides and TCDD (the highly toxic contaminant of 2,4,5-T and Silvex) are discussed in relation to their behavior in the forest environment and their bioaccumulation in animals.

Risk is the predominant technical issue in the controversy about use of herbicides in the forest. Scientists believe more data is needed so forest managers can make better assessments of risk. Information is particularly limited on the effects of phenoxy herbicides and TCDD on air and streams.

Copies of *The movement, persistence, and fate of the phenoxy herbicides and TCDD in the forest,* from "Residues Review", Volume 80, by Logan A. Norris, may be obtained from the Pacific Northwest Station.

Cost/benefits of fire management activities

To ensure that fire management programs are cost effective and responsive, fire managers and planners have to be able to compare costs and benefits. Changes in fire protection programs can cause changes in the number, size, or severity of wildfires. Is the change in program cost consistent with the change in net losses due to wildfire? Changes in fire use programs also are to be cost effective and responsive. Does a prescription fire create enough net benefits to justify its cost?

To answer such questions as accurately as possible, managers require good estimates of the costs, losses, and benefits associated with both wildfires and prescription fires. These three factors vary a great deal depending on size, intensity, fire location, fuel, weather conditions, and many other circumstances.

The Intermountain Station has published a guidebook containing fire valuation procedures that provide an estimate of fire costs, losses, and benefits. The procedures call for post-fire examination of each class C and larger wildfire and each prescription fire, leading to a summary of costs, losses, and benefits for each. The procedures are included in *Fire Costs, Losses, and Benefits: an Economic Procedure*, General Technical Report INT-108-FR 29, by Robert J. Marty and Richard J. Barney. Although the procedures were developed primarily for Forest Service use, they are adaptable to other agency and individual situations.

Write to the Intermountain Station for a copy.

"SCANIT"—new aid for processing map and photo data

A new series of computer programs, called "SCANIT", can be used to prepare data from maps and photos for later processing through computerized land-information systems. SCANIT was designed to be used with systems like the RID*POLY Geographic Information System: RID*POLY tabulates and stores such information as acreages of various soil or timber types on a given National Forest.

The SCANIT programs are used with an automated scanner to convert information from maps and photos into digits that can be read by computer. SCANIT can also be used to check and edit this information before it goes to the computer for analysis.

Other uses of SCANIT, and information about the equipment required, are described in *SCANIT: Centralized Digitizing of Forest Resource Maps or Photographs*, General Technical Report PSW-53, by Research Forester Elliot L. Amidon and Computer Systems Analyst E. Joyce Dye of the Pacific Southwest Station. Instructions on how to use each of the SCANIT options are included in the Report: copies are available from the Pacific Southwest Station.

Prospective users who would like SCANIT programs copied onto magnetic tape should write Joyce Dye at the Pacific Southwest Station in Berkeley for further information, or should phone her at (415) 486-3127 (FTS: 449-3127).

Using a computer to estimate yarding costs

A program designed for a pocket computer that will enable logging operators and planners to save time and money is described in an article by Ronald Mifflin of the Pacific Northwest Station.

Mifflin gives the step-by-step procedure to use basic costs and production values to rapidly figure the cost of a yarding operation. The impact of cost or production changes can be quickly pinpointed, and the economics of alternative yarding systems compared.

Machine rate is the hourly cost of owning and operating equipment. Production rate is the volume of timber brought to the landing per unit of time. These, along with the costs of moving the yarder and rigging the lines and the cost of moving equipment in and out, can be expressed in a formula to determine yarding cost.

The program is designed for use in a Hewlett-Packard 97, 67, or 41C calculator and is adaptable to other programmable calculators.

Copies of *Estimating Yarding Costs by Computer*, in the "BC Lumberman," July, 1981, by Ronald Mifflin, are available from the Pacific Northwest Station.

Forest fuels—gauging how much is on the ground

The jumble of cones and needles, small branches and twigs, broken limbs, and decaying trees on a forest floor is natural fuel for wildfires. In most stands, as the amount of this debris builds up, so does the fire hazard.

This is why two northern Californians have prepared a field guide for estimating how much natural fuel is on the ground in a given forest. Fuels management specialists can use this information to develop strategies for handling these hazardous accumulations of flammable fuels.

The new handbook applies to stands of ponderosa pine, lodgepole pine, white fir, red fir, mountain hemlock, or mixed conifers in the southern Cascades and northern Sierra Nevada of California. Authors Ken Blonski of the Plumas National Forest and John Schramel, formerly of the Plumas, say the 145-page publication presents a "fast, easy, and inexpensive way to quantify forest residues."

A series of color photos show typical accumulations of fuels in 56 representative stands. Each photo is accompanied by a data sheet, which gives detailed information about the stand and about the amounts of residues that could occur on the site. The reader needs only to find the photo that matches the conditions on a given area. The data sheets give the weight (in tons) and the volume (in cubic feet) for fuels ranging in size from less than one-fourth inch in diameter to 20 inches or more in diameter.

Although the handbook is intended primarily for use in fuels management, Blonski and Schramel say the guide should also be an aid in planning timber sales, in developing wilderness management plans, and in evaluating accumulated fuels as a possible source of energy. They patterned the photo guide after the approach developed by researchers Wayne Maxwell and Franklin Ward of the Pacific Northwest Station.

For copies of the northern California handbook, write to the Pacific Southwest Station, Berkeley, for General Technical Report PSW-56, *Photo Series for Quantifying Natural Forest Residues: Southern Cascades, Northern Sierra Nevada*.

Managing blowing snow

Three case studies on the design and performance of snow retention, snow fencing, and snow harvesting treatments are discussed in a new publication by two authors from the Rocky Mountain Station.

The study on snow retention explains how strips of crested wheatgrass planted on low-growing, sagebrush rangeland doubled snow accumulation compared to untreated rangeland. The strips were 3 meters wide and oriented with their long axis perpendicular to prevailing wind direction.

The snow fencing study describes how a snow fence 3.05 meters in height was constructed along the windward side of a stream channel that led to an irrigation reservoir. Without the snow fence, natural snow storage in the channel would have been 27 cubic meters of water per meter of channel length. After fence construction, actual storage was 81 cubic meters of water per meter of channel length, an increase in water storage of 54 cubic meters per meter of channel.

The third study describes a treatment in which sagebrush was removed from the windward side of a ridge. This allowed the wind to move snow to the leeward side of the ridge where it accumulated in a large drift. The treatment increased the transport of water contained in snow by 24 cubic meters per meter of ridge length.

The report, written by David L. Sturges and Ronald D. Tabler, is titled, *Management of blowing snow on sagebrush rangelands*. It is available from the Rocky Mountain Station (mailing address on inside front cover).

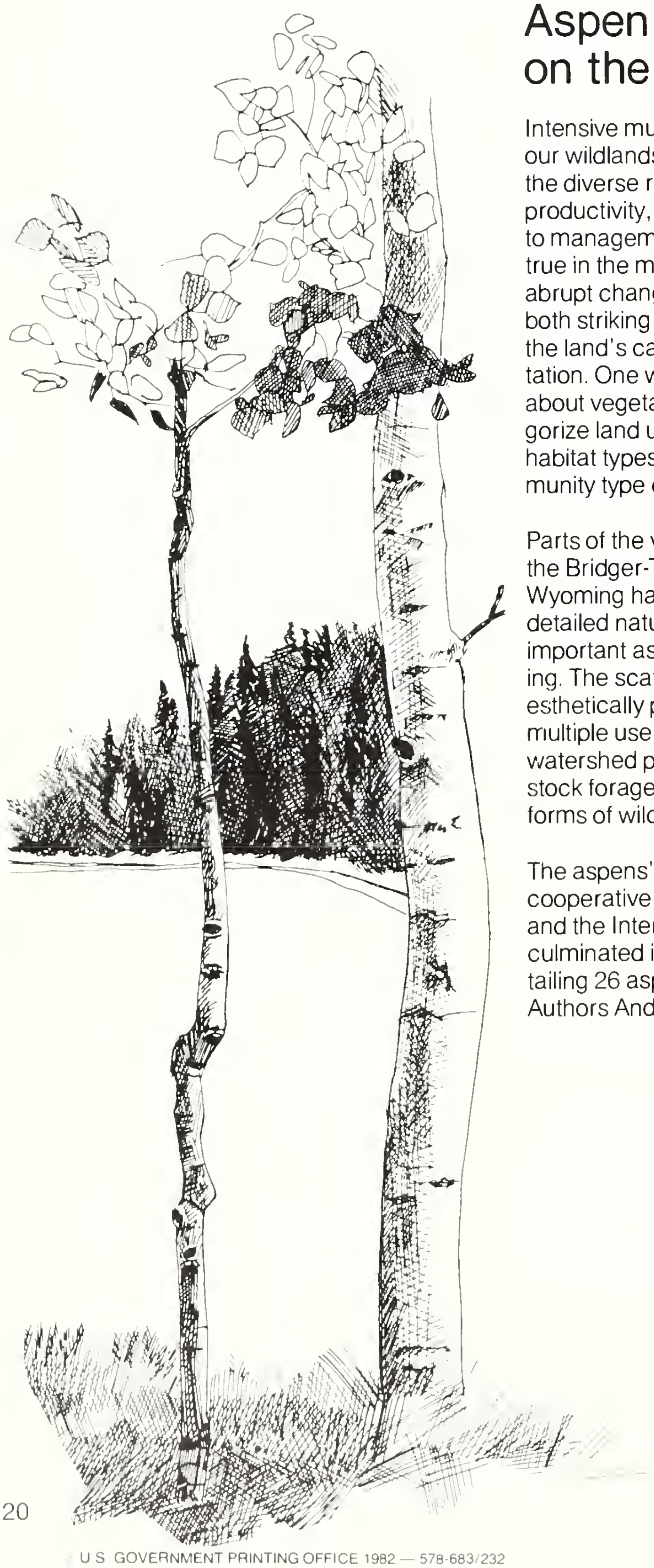
New techniques to determine age of quaking aspen

Methods for determining the age of trees range from the simple to the complex and entail approaches as diverse as using oil, chemicals, and hot black coffee. Determining the age of some trees such as quaking aspen, however, is more difficult. Most researchers view specimens of these trees through dissecting or regular microscopes. They consider laboratory analysis essential for accuracy.

The diffuse-porous wood of quaking aspen (*Populus tremuloides* Michx.) makes the annual rings difficult to distinguish, even with complicated procedures. A biological technician at the Intermountain Station, however, has adapted a technique that is simple, requires little specialized equipment, and in most cases yields satisfactory results.

The technique, described in a recent Station publication, is used to analyze a shaved translucent increment core with simultaneous direct and reflected flourescent lighting to discern rings. The 5-page report tells how proper field procedures, such as boring the correct side of the aspen tree, recording the core height, and avoiding heart rot, can improve the accuracy of the ages obtained.

The report is entitled *Field and Laboratory Methods for Age Determination of Quaking Aspen*, by Robert B. Campbell, Jr. For a copy, write to the Intermountain Station and request Research Note INT-314-FR 29.



Aspen classification on the Bridger-Teton

Intensive multiple use management of our wildlands requires knowledge of the diverse resources, their potential productivity, and their likely response to management. This is especially true in the mountainous West where abrupt changes in environment create both striking and subtle differences in the land's capability to produce vegetation. One way to acquire knowledge about vegetation resources is to categorize land units. Approaches include habitat types, cover type, and community type classification systems.

Parts of the vegetation complex on the Bridger-Teton National Forest in Wyoming have been classified, but a detailed natural classification for the important aspen lands has been lacking. The scattered aspen groves are esthetically pleasing, highly valued multiple use areas, providing good watershed protection, abundant livestock forage, and habitat for many forms of wildlife.

The aspens' importance prompted a cooperative effort between the Forest and the Intermountain Station that has culminated in a new publication detailing 26 aspen community types. Authors Andrew P. Youngblood, plant ecologist on the Bridger-Teton, and Walter F. Mueggler, leader of the Station's Aspen Ecology research work unit, provide a diagnostic key that uses indicator plant species for field identification of the community types. The scientists discuss vegetation composition, environment, productivity, relationship to surrounding vegetation, and successional status. Tables and photographs illustrate many of the 26 types.

Youngblood and Mueggler point out that community type classification has several benefits for the resource manager. It communicates ideas about similar vegetation and environments, suggesting that such sites might respond to similar management actions. The community type classification, when coupled with other systems, provides management with realistic alternatives for resource use.

For your copy of *Aspen Community Types on the Bridger-Teton National Forest in Western Wyoming,* write to the Intermountain Station and request Research Paper INT-272-FR 29.

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Rainfall on snowpack in western Oregon

Rainfall on snowpacks, a common occurrence between 1,200 and 3,600 feet elevations in Western Oregon, has been a dominant factor causing landslides and depositing large amounts of sediment and debris in streams. This, in turn, may drastically affect the stream and its impact on low-lying areas.

Sometimes the result of this phenomenon has been large scale flooding of urbanized areas such as in 1964, 1965, and 1974 when millions of dollars in damage was caused in the Willamette Valley of Oregon by warm rain falling on snowpacks.

Snowpacks in Western Oregon are "warm"—they have interior temperatures at or near 0 degrees C so that little energy is required to initiate melting. A warm pack can yield water quickly during a period of high air temperature and rainfall.

Researchers are concerned about whether clearcut logging exacerbates potential landslides and flooding when all other conditions of snow, warm air, and heavy rains are right. It is possible that clearcuts could increase water input to soil by 10 to 25 percent where packs are shallow.

Without additional studies, however, it cannot be said with certainty that clearcutting does or does not affect rate of snowpack melt during rainfall. In light of the possible consequences of increasing melt by timber harvest, a strong argument is presented for more study of this phenomenon.

Copies of *Some Characteristics and Consequences of Snowmelt during Rainfall in Western Oregon*, in "Journal of Hydrology" 53(1981), by R.D. Harr is available from the Pacific Northwest Station.

Don't miss the next issue. You'll read about the latest in fire economics research; learn the importance of birds and ants as predators of the western spruce budworm; and discover a computer tool for surface mine reclamation planning, called SEAMPLAN. You'll also have a chance to review several new research publications. WATCH FOR IT!

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